

80° or 90° northward, making our position exactly in the centre of the circle. At the same time there was an ordinarily bright halo around the moon. This large arch was plainer than the halo and was plainest where it was clearest of clouds. There were a few hazy clouds, and at times they encroached upon the circle and made it fade, but it returned as the haze blew away. Occasionally bright spots came into the perimeter to last a few moments only. It seemed to become a very little smaller after some five or six minutes. In fifteen minutes it was gone, but the halo around the moon remained. The cloudiness remained about the same."

METEORS.

The distribution of meteors, by dates, was as follows: 1st, Matanzas, Fla. 2d, Lansing, Mich.; Beverly, N. J. 3d, Harrisonville, Mo. 4th, Fort Sully, Dak.; Pontiac, Mich. 5th, Pontiac, Mich.; Palo Alto, Miss. 6th, Vevay, Ind. 7th, Nashua, N. H. 9th, Tremont, Mich. 10th, Vevay, Ind.; Yates Centre, Kans.; Protom, Mo. 12th, Keeler, Cal.; Woonsocket, Dak.; Barren Creek Springs, Md.; Cedar Springs, S. C. 13th, Cairo, Ill. 14th, Holyoke, Mass.; Beverly, N. J. 19th, Princeton, Mo. 20th, Little Rock, Ark.; Middlebrook, W. Va. 22d, Tremont, Mich.; Protom, Mo. 23d, New Market, Ala.; Fox Creek, Mo. 24th, Providence, Mass.; Palo Alto, Miss. 27th, Matanzas, Fla. 28th, Orono, Me.; Ypsilanti, Mich.; Beverly, N. J. 29th, Dale Enterprise, Va. 30th, Clinton, Iowa; Barren Creek Springs, Md.; Beverly, N. J. 31st, Glenwood, Iowa; Bendena and Yates Centre, Kans.; Protom, Mo.

The following are more notable meteoric displays reported:

Lead Hill, Boone Co., Ark.: a large, bright meteor was observed in the northeastern sky at 4.55 a. m., 2d. It moved toward the northwest, and when near the horizon broke into two parts; the meteor left a trail of light in its wake.

Cape Henry, Va.: several small meteors were observed on the 6th; one large one, noted in the northeast at 7 p. m., moved horizontally in a westerly direction and exploded after a flight of five seconds, its colors being red and violet.

Orono, Me.: a brilliant meteor was observed passing across the northwest sky at 5.05 p. m., 28th; it left a long train of light in its passage.

Willow, Colusa Co., Cal.: a meteor was observed at 10.45 p. m., 29th; it passed slowly from near the zenith south-south-eastward and disappeared below the horizon; duration of passage about six seconds.

MIRAGE.

Mirage were observed as follows: Yuma, Ariz., 1st; San

Diego, Cal., 5th; Kimball, Dak., 1st, 3d, 28th; Webster, Dak., 30th, 31st; Woonsocket, Dak., 3d, 29th, 30th, 31st; Hampton, Iowa, 8th, 29th; Hay Springs, Nebr., 14th; Brady, Tex., 11th; Cape Henry, Va., 25th.

SUN SPOTS.

Prof. F. P. Leavenworth, director, Haverford College Observatory, Pa. (observed by Mr. H. V. Gummere, assistant):

Date, December, 1888.	Number of new—		Disappeared by solar rotation.		Reappeared by solar rotation.		Total number visible.		Faculae.		Remarks.
	Groups.	Spots.	Groups.	Spots.	Groups.	Spots.	Groups.	Spots.	Groups.	Spots.	
1, 3 p. m. ...	0	0	0	0	0	0	1	13	0	0	Definition poor.
4, 10 a. m. ...	0	0	0	0	0	0	1	9	2	4	Definition good.
5, 13 m. ...	0	10	0	0	0	0	1	19	2	14	Definition very good.
6, 10 a. m. ...	0	0	0	0	0	0	1	5	5	9	Definition good.
7, 12 m. ...	0	0	0	0	0	0	1	1	1	13	Definition very poor.
8, 9 a. m. ...	0	2	0	0	0	0	1	3	4	27	Definition fair.
12, 11 a. m. ...	0	0	1	3	0	0	0	0	2	7	Definition poor.
13, 11 a. m. ...	0	0	0	0	0	0	0	0	0	3	Definition good.
14, 11 a. m. ...	0	0	0	0	0	0	0	0	0	0	Definition very poor.
15, 11 a. m. ...	1	11	0	0	0	0	1	11	3	11	Definition good.
19, 3 p. m. ...	0	5	0	0	0	0	1	16	3	4	Definition good.
20, 12 m. ...	0	1	0	0	0	0	1	17	Definition poor; too misty for faculae.
21, 11 a. m. ...	0	0	0	0	0	0	1	8	5	19	Definition good.
22, 10 a. m. ...	0	1	0	8	0	0	0	0	0	0	Definition very poor.
24, 11 a. m. ...	1	1	0	0	0	0	1	1	7	20	Definition very good.
25, 12 m. ...	0	0	0	0	0	0	0	0	0	21	Definition very good.
26, 12 m. ...	0	0	0	0	0	0	0	0	0	4	Definition poor.
28, 11 a. m. ...	0	0	0	0	0	0	0	0	0	15	Definition good.
29, 11 a. m. ...	1	1	0	0	0	0	1	1	9	23	Definition good.

Mr. John W. James, Riley, McHenry Co., Ill.: one of the large spots (seen near e. edge November 27th) vanished December 4th, when two days past sun's meridian; the other estimated 29,000 miles diameter disappeared, by the solar rotation, 7th, but failed to reappear, when due, on e. edge, 19th; a group of small spots two days from w. edge disappeared 21st, and none seen the rest of the month.

Mr. H. D. Govey, North Lewisburgh, Champaign Co., Ohio: sun spots were observed on the 4th and 5th.

SAND STORMS.

Sand storms were reported as follows: Little Rock, Ark., 20th; Dodge City, Kans., 2d, 14th, 15th, 22d, 23d.

VERIFICATIONS.

INDICATIONS FOR 24 HOURS IN ADVANCE.

Percentages of indications verified, December, 1888.

States.		States.	
Maine	80.6	Tennessee	86.8
New Hampshire	82.4	Kentucky	84.0
Vermont	80.8	Ohio	76.6
Massachusetts	85.2	West Virginia	82.7
Rhode Island	83.5	Indiana	81.4
Connecticut	84.7	Illinois	82.1
Eastern New York	79.7	Lower Michigan	81.7
Western New York	79.7	Upper Michigan	78.8
Eastern Pennsylvania	85.5	Wisconsin	85.1
Western Pennsylvania	73.9	Minnesota	84.1
New Jersey	87.7	Iowa	86.7
Delaware	90.7	Kansas	89.0
Maryland	89.0	Nebraska	85.8
District of Columbia	89.1	Missouri	83.5
Virginia	86.6	Colorado	88.0
North Carolina	90.7	Dakota	82.4
South Carolina	91.7	Southern California *	90.7
Georgia	91.8	Northern California *	84.4
Eastern Florida	82.3	Oregon *	73.5
Western Florida	83.5	Washington Territory *	77.4
Alabama	87.2	By elements: Weather	87.3
Mississippi	83.5	Temperature	80.2
Louisiana	82.8	Monthly percentage of weather and	
Texas	83.1	temperature combined †	84.5
Arkansas	87.3		

* In determining the monthly percentage of weather and temperature combined, the Pacific coast states are not included. † The monthly percentage of weather and temperature combined is determined by multiplying the percentage of weather by 6, and the percentage of temperature by 4, and dividing their sum by 10.

The percentages of verifications of the 8 p. m. daily indications for December, 1888, as determined from comparison of succeeding telegraphic reports, are given in the table below.

The predictions for districts east of the Rocky Mountains for December, 1888, were made by Assistant Professor H. A. Hazen, and those for the Pacific Coast districts were made at San Francisco, Cal., by 2d Lieutenant J. E. Maxfield, Signal Corps; the verifications for all districts were determined by Assistant Professor C. F. Marvin.

CAUTIONARY SIGNALS FOR DECEMBER, 1888.

Statement showing percentages of justifications of wind signals and cold-wave signals for the month of December, 1888:

Wind signals.—(Ordered by Assistant Prof. H. A. Hazen.) Total number of signals ordered, ninety-two; justified as to velocity, wholly, fifty-nine, partly, thirteen; justified as to direction, eighty-seven. Number of cautionary signals ordered, sixty; justified, wholly, thirty-five, partly, seven. Number of

storm signals ordered, thirty-two; justified, wholly, twenty-four, partly, six. Number of signals ordered for easterly winds, twenty-nine; justified, twenty-six. Number of signals ordered for westerly winds, sixty-three; justified, sixty-one. Number of signals ordered late, eight. Number of winds without signals, seventeen. Percentage of justifications, 72.4.

Cold-wave signals.—(Ordered by Assistant Prof. T. Russell.) Total number of signals ordered, two hundred and seventy-three; justified, wholly, one hundred and thirty-five, of which fifteen were ordered late, partly justified, ten. Number of severe cold waves without signals, fifteen. Percentage of justifications, 49.5.

Percentages of local verifications of weather and temperature signals as reported by directors of the various State Weather Services for December, 1888.

States.	Weather.	Temperature.	States.	Weather.	Temperature.
Illinois	88.0	83.0	New Jersey	86.6	87.3
Indiana	91.1	84.1	New York	85.0	86.0
Kansas	87.9	81.7	North Carolina	84.5	80.2
Kentucky	80.4	83.8	Ohio	86.0	82.0
Louisiana (northern)	91.0	100.0	South Carolina	87.5	91.5
Louisiana (southern)	92.0	90.0	Tennessee	90.8	88.5
Michigan	79.6	79.1	Texas	80.3	78.3
Nebraska	90.6	91.1			

STATE WEATHER SERVICES.

[Temperature in degrees Fahrenheit; precipitation, including melted snow, in inches and hundredths.]

The following extracts are republished from reports for December, 1888, of the directors of the various state weather services:

ALABAMA.

The season has been mild and pleasant, although the average temperature was 4.5 below the normal. This is to be accounted for upon the ground that the reduction of temperature was distributed over the entire period with but three or four really cold days, and the fair, sunshiny days were largely in the majority. The weather was generally cool enough, however, to produce light frosts and thin ice frequently during the month. The lowest temperature recorded was 13, in the northeastern portion of the state. In middle and southern Alabama the depression was not so low. Every December since the organization of the state service has recorded a minimum temperature below that of December just closed. In 1884, 6 was registered at one or more stations; in 1885, 12; in 1886, zero, and in 1887, 10. The rains were not heavy, and the total average precipitation was 1.98 below the normal. The winter wheat has suffered slightly on account of the deficiency of rain.

Summary.

Temperature.—Monthly mean, 46; highest monthly mean, 51.2, at Troy; lowest monthly mean, 40.3, at Valley Head; maximum, 71, at Bermuda, 25th; minimum, 13, at Valley Head, 20th; range for state, 58; greatest local monthly range, 53, at Troy; least local monthly range, 31, at Selma.

Precipitation.—Average for the state, 2.71; greatest, 4.32, at Tuscaloosa; least, 1.86, at Florence.

Wind.—Prevailing direction, northwest.—*P. H. Mell, Signal Corps, Auburn, director.*

ARKANSAS.

Summary.

Temperature.—Monthly mean, 43.8; highest monthly mean, 50.7, at Forrest City; lowest monthly mean, 39.6, at Lead Hill; maximum, 73, at Texarkana, 6th; minimum, 15, at Heber, 20th; greatest local monthly range, 53, at Conway; least local monthly range, 38, at Camden.

Precipitation.—Average for the state, 3.57; greatest, 7.16, at Ozone; least, 0.23, at Prescott.—*Prof. John C. Branner, Little Rock, director; W. U. Simons, Corporal, Signal Corps, assistant.*

ILLINOIS.

The past month has been a most remarkable one, and will long be remembered as one of the mildest of which there is any record. Never before has the average temperature of December been so high, the snowfall so light, nor the minimum temperature so high. The precipitation has been below the average, and while frosts have been as numerous as usual, they have been unusually light, and the ground but very slightly frozen at any time. In the northern counties the ground was considerably frozen, but in the central and southern counties it was scarcely frozen at all. Snow fell on several occasions, but was always light, and remained on the ground but a short time—excepting the northern counties not more than a day at one time; and at the end of the month no snow remained on the ground in the state, except in a few of the extreme northern counties, and even there very little of it.

Summary.

Temperature.—The average for the month, 33.5, was 5.7 above the average of the past ten years, an excess that raises the yearly average considerably, so that it is only 0.9 below the mean of the past thirteen years.

Precipitation.—The rainfall was only 0.40 below the average of the ten previous Decembers and was very equally distributed over the state, the average being the same for the three divisions.

Wind.—Prevailing direction, southwest.—*Col. Charles F. Mills, Springfield, director; James Cassidy, Sergeant, Signal Corps, assistant.*

INDIANA.

December, 1888, will be remembered as one of the mildest, and at many stations the mean temperature was the highest on record in Indiana for that month; steady high temperature prevailed and the absence of sudden changes to low temperature, below zero, was a marked feature this year. Warmer

periods occurred on the 7th and 8th, 15th and 16th, and from the 24th to 26th; while colder periods were very uninteresting and of no note whatever. The departure of the mean temperature from the normal was nearly +4.0.

The precipitation for the month was exceedingly small, and the small amount of snow which was precipitated did not cover the ground for any great length of time, as it melted or evaporated soon after it had fallen. The greatest amount of rain, and that less than 1.00 in twenty-four hours, was measured nearly everywhere on the 15th and 16th, on the approach and passage of the lowest barometric area. The average amount of precipitation was about 1.64 below the normal for December.

Summary.

Temperature.—Monthly mean, 34.6; highest monthly mean, 39.5, at Marengo; lowest monthly mean, 30.4, at Maury; maximum, 62.5, at Cannelton, 25th; minimum, 7.0, at Maury, 14th; range for state, 55.5; greatest local monthly range, 48.0, at Maury and Butlerville; least local monthly range, 37.0, at Columbus and De Gonia Springs.

Precipitation.—Average for the state, 1.78; greatest, 3.65, at Huntingburgh; least, 1.19, at Vevay.

Wind.—Prevailing directions, south and southwest.—*Prof. H. A. Huston, La Fayette, director; C. F. R. Wappenhans, Sergeant, Signal Corps, assistant.*

IOWA.

The month was fair, dry, and extraordinarily warm, very moderate westerly winds prevailing. The mean temperature was 7.5 above the normal. During the preceding twenty years December has but three times been as warm, viz., in 1875, 1877, and 1881; the warmest December being that in 1877, which was 17 above the normal. The highest temperature at the central station was 58, on the 23d, a temperature which had not been reached in December since 1877; the lowest, 10, on the 28th. During the preceding fifty years there have been only four Decembers without temperatures falling to or below zero, viz., in 1846, 1858, 1877, and 1881.

The total amount of precipitation in December exceeded 2.00 in a broad belt running west of the Mississippi, and extending in southern Iowa as far as to Clarke and up to Story counties; west of this belt, and half way up the Missouri, the rainfall exceeded 1.00; the northwest and west, down to Adams county, received less than 1.00.—*Dr. Gustavus Hinrichs, Iowa City, director.*

Summary.

Temperature.—Monthly mean, 35.9; highest monthly mean, 40.0, at Wellington; lowest monthly mean, 30.8, at Marydale Farm; maximum, 74, at Gorman, 4th; minimum, —3, at Topeka, 28th; range for state, 77; greatest local monthly range, 66, at Concordia and Topeka; least local monthly range, 43, at Victoria; greatest daily range, 57, at Santa Fé, 4th; least daily range, 2, 25th, at Halstead.

Precipitation.—Average for the state, 0.52; greatest, 3.89, at Independence; least, 0.00, at Grainfield and Grinnell.

Wind.—Prevailing direction, south.—*Prof. J. T. Lovewell, Topeka, director; T. B. Jennings, Sergeant, Signal Corps, assistant.*

KENTUCKY.

Summary.

Temperature.—The December mean for the state was 38.7, which is a slight